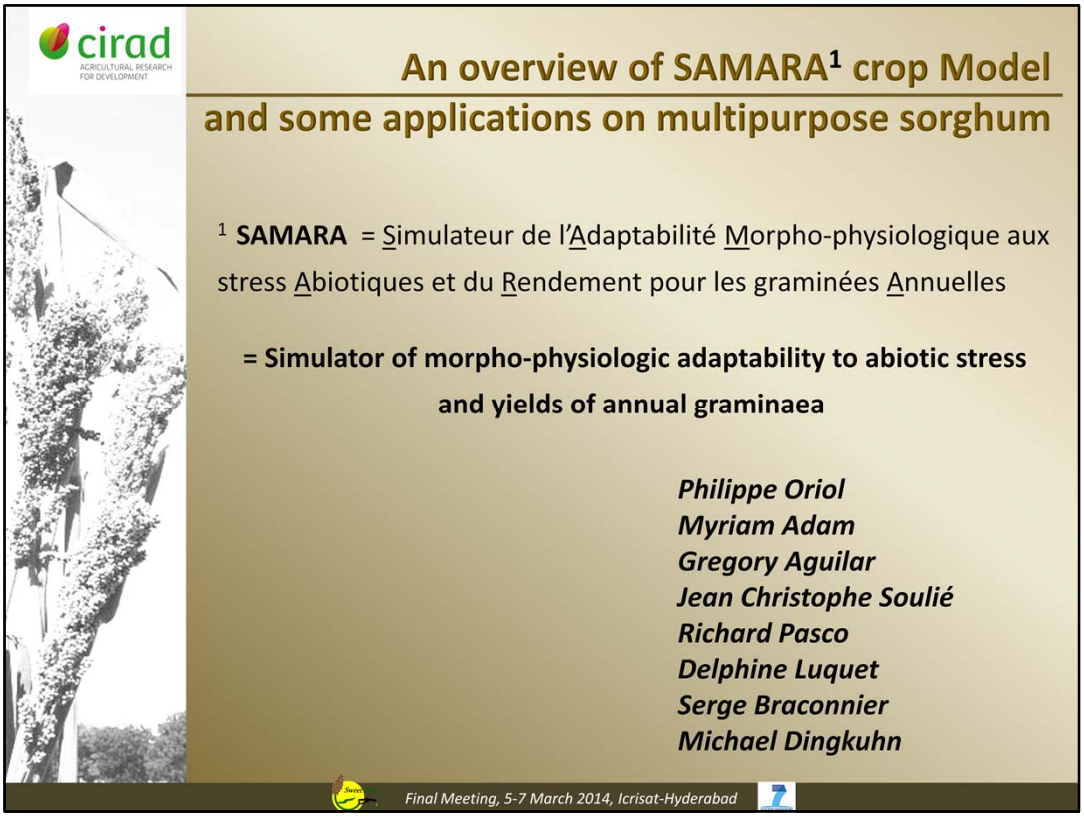
Oriol, P., Adam, M., Aguilar, G., Soulie, J.C., Pascol, R., Luquet, D., Braconnier, S., Dingkuhn, M. 2014. An overview of SAMARA crop Model and some applications on multipurpose sorghum. [Slideshow and Abstract]. 15 vues. Sweet Sorghum an Alternative Energy Crop. Sweet Fuel Project Final Meeting, 2014/03/05-07, Hyderabad, India.

Le modèle de culture SAMARA développé par le CIRAD a été validé sur les données de croissance de variétés de Sorgho Biomasse issues du projet Sweet Fuel. L'exposé montre comment le modèle simule la répartition de la production de biomasse entre les différents organes aériens de la plante (feuilles, tiges, panicules) en fonction des conditions environnementales. Pour exemple, le modèle a été calibré sur les données obtenues pour la variété M-81E sur des essais menés en Floride par l'Everglades Research and Education Center. Dans ces conditions, SAMARA reproduit correctement les cycles de culture avec néanmoins une surestimation de 7 jours dans le cas d'un semis précoce. La production de biomasse aérienne totale est simulée avec une erreur (RMAE) de 10%, tandis que la tendance à produire proportionnellement plus de grains lors d'un semis tardif par rapport à un semis précoce est bien prédite par le modèle. Le modèle SAMARA se montre ainsi utilisable pour la recherche dans les objectifs d'exploration d'idéotypes et de caractérisation de TPE (Target Population of Environments).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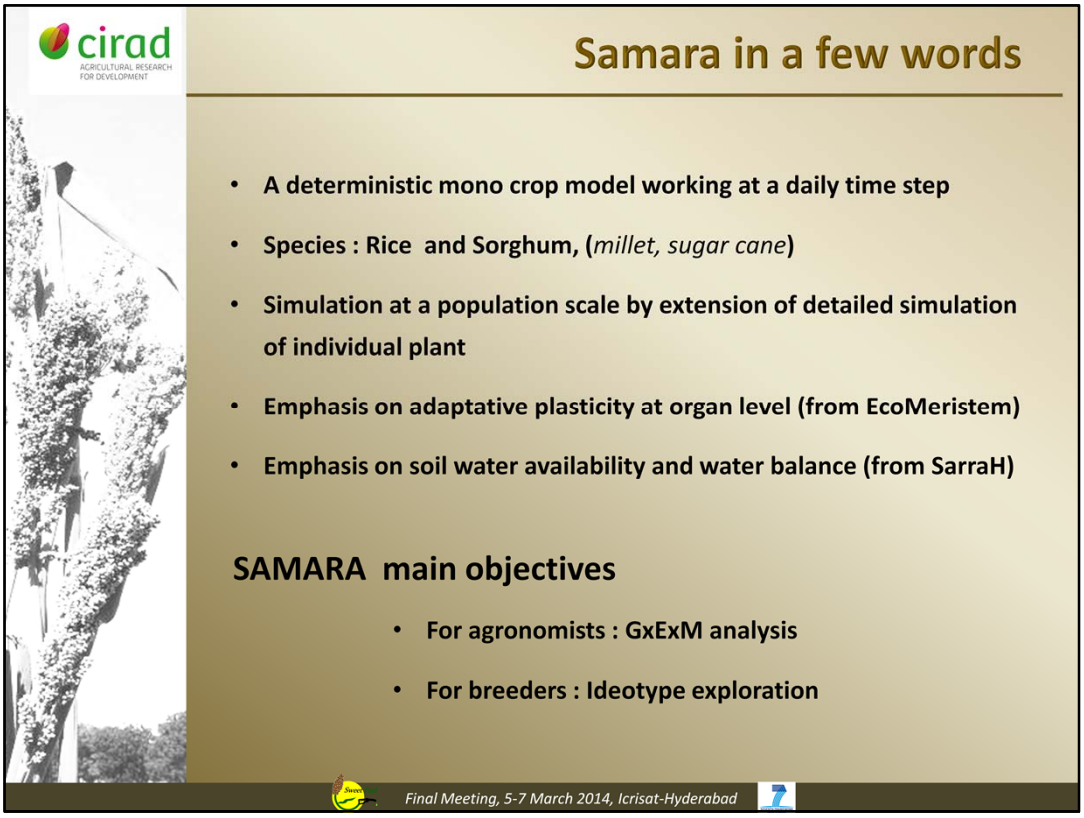
AGRICULTURAL RESEARCH FOR DEVELOPMENT
An overview of SAMARA[1] crop Model and some applications on multipurpose sorghum
[1] SAMARA = Simulateur de l'Adaptabilité Morpho-physiologique aux stress Abiotiques et du Rendement pour les graminées Annuelles
= Simulator of morpho-physiologic adaptability to abiotic stress and yields of annual graminaea
Philippe Oriol
Myriam Adam
Gregory Aguilar
Jean Christophe Soulié
Richard Pasco
Delphine Luquet
Serge Braconnier
Michael Dingkuhn
Final Meeting, 5-7 March 2014, Icrisat-Hyderabad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AGRICULTURAL RESEARCH FOR DEVELOPMENT
Samara in a few words
• A deterministic mono crop model working at a daily time step
• Species : Rice and Sorghum, (millet, sugar cane)
• Simulation at a population scale by extension of detailed simulation of individual plant
• Emphasis on adaptative plasticity at organ level (from EcoMeristem)
• Emphasis on soil water availability and water balance (from SarraH)
SAMARA main objectives
• For agronomists : GxExM analysis
• For breeders : Ideotype exploration
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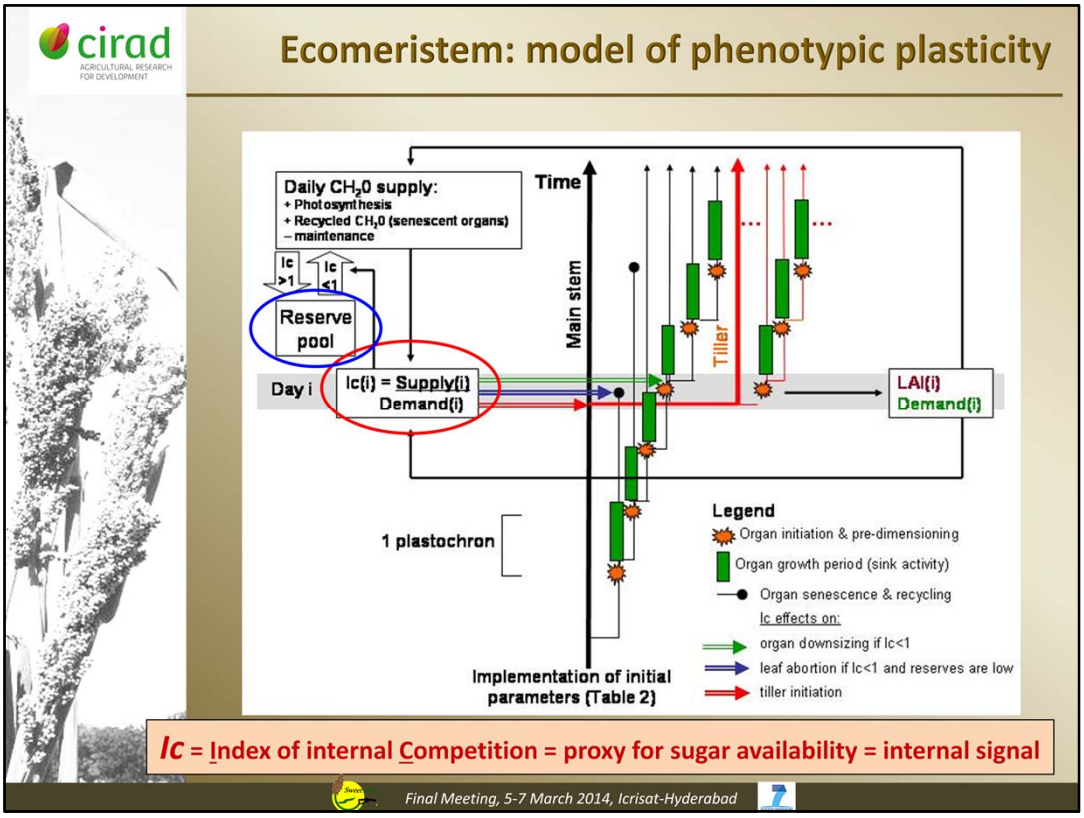
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Ecomeristem: model of phenotypic plasticity
Daily CH2O supply:
+ Photosynthesis
+ Recycled CH2O (senescent organs)
– maintenance
Ic >1
Ic ≤1
Reserve pool
Day i
Ic(i) = Supply(i) / Demand(i)
Time
Main stem
Tiller
LAI(i) Demand(i)
1 plastochron
Implementation of initial parameters (Table 2)
Legend
Organ initiation & pre-dimensioning
Organ growth period (sink activity)
Organ senescence & recycling
Ic effects on:
organ downsizing if Ic<1
leaf abortion if Ic<1 and reserves are low
tiller initiation
Ic = Index of internal Competition = proxy for sugar availability = internal signal
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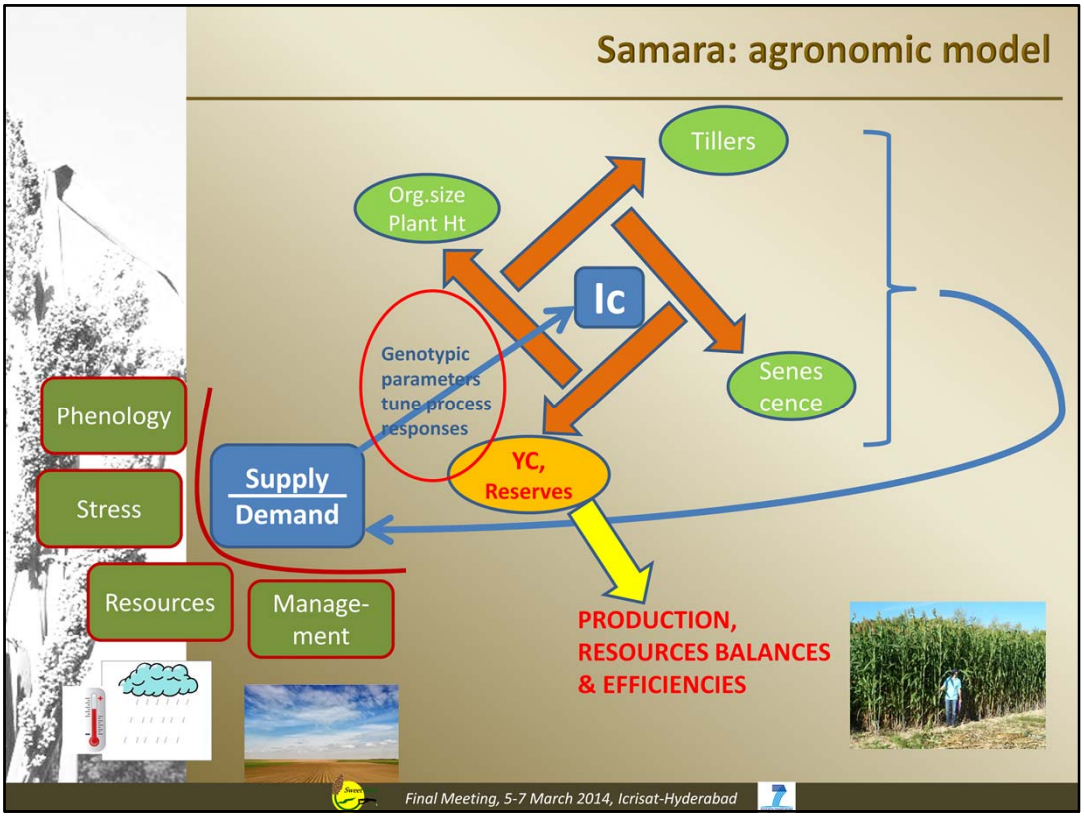
Samara: agronomic model
Tillers
Org.size
Plant Ht
Ic
Genotypic
parameters
tune process
responses
Senes
cence
Phenology
Stress
Resources
Manage-
ment
Supply
Demand
YC,
Reserves
PRODUCTION,
RESOURCES BALANCES
& EFFICIENCIES
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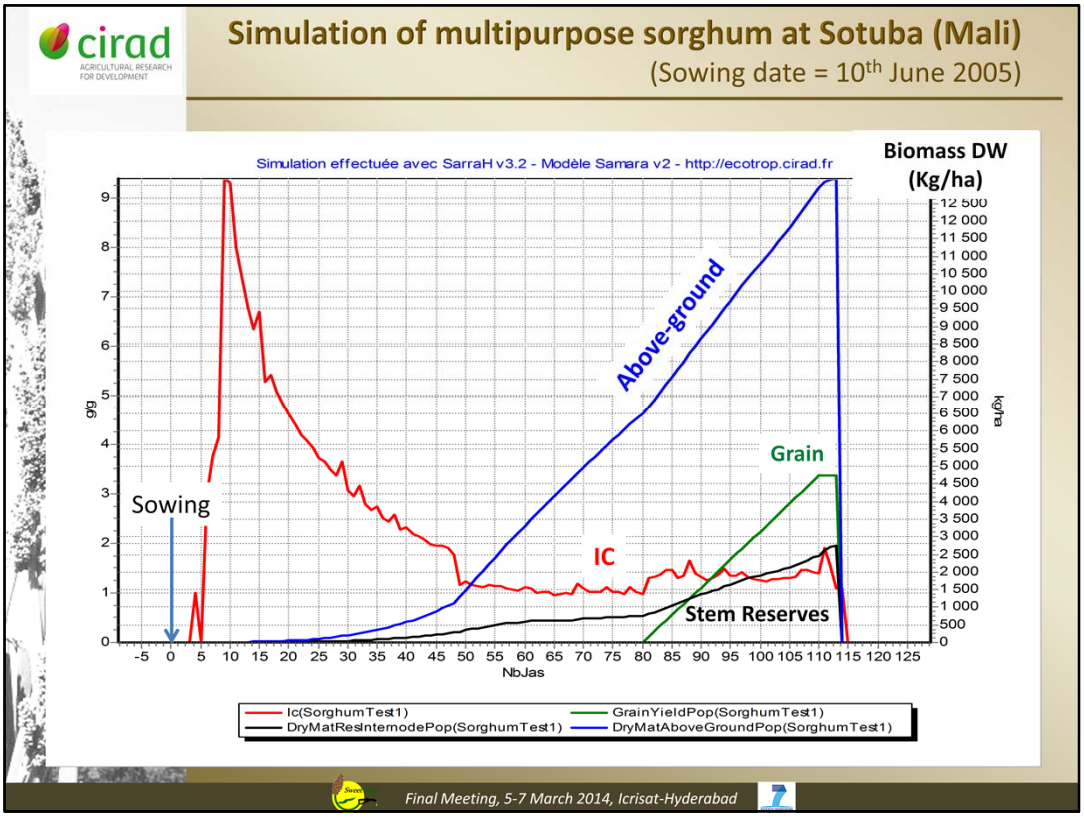


In order to illustrate how the model is working

This is an example taken from a Multipurpuse Sorghum study performed in Mali.

Here, SAMARA simulates the growth of a sorghum variety sowed early (on 10th of june) , which is a classical period for planting sorghum there.

On the absis axe, you can find the days after planting.

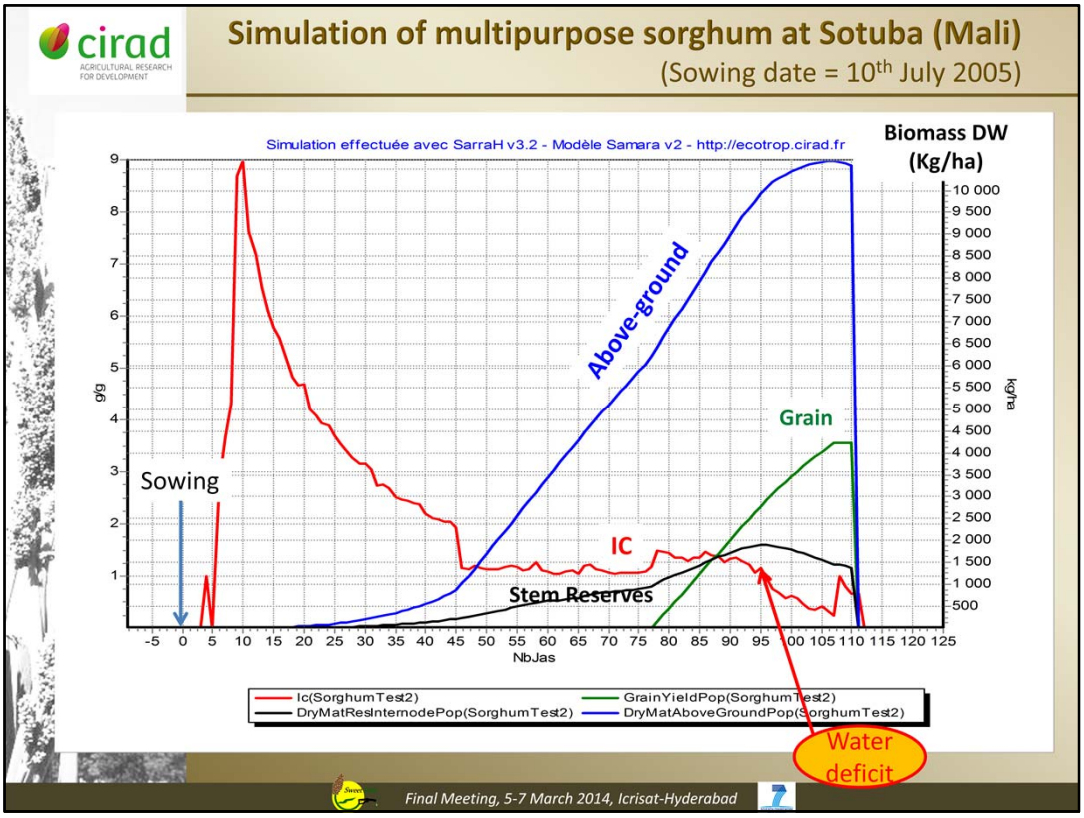
0n the vertical axes, on the left this is Ic

And on right axe The biomass Dw .

If we look at the Ic index, it is high at the beginning of the crop (it is a normal feature as supply is large in front of demand at this stage)

The it stays nearly to 1 during all the growing period till harvest. That means that sorghum was not affected by any stress.

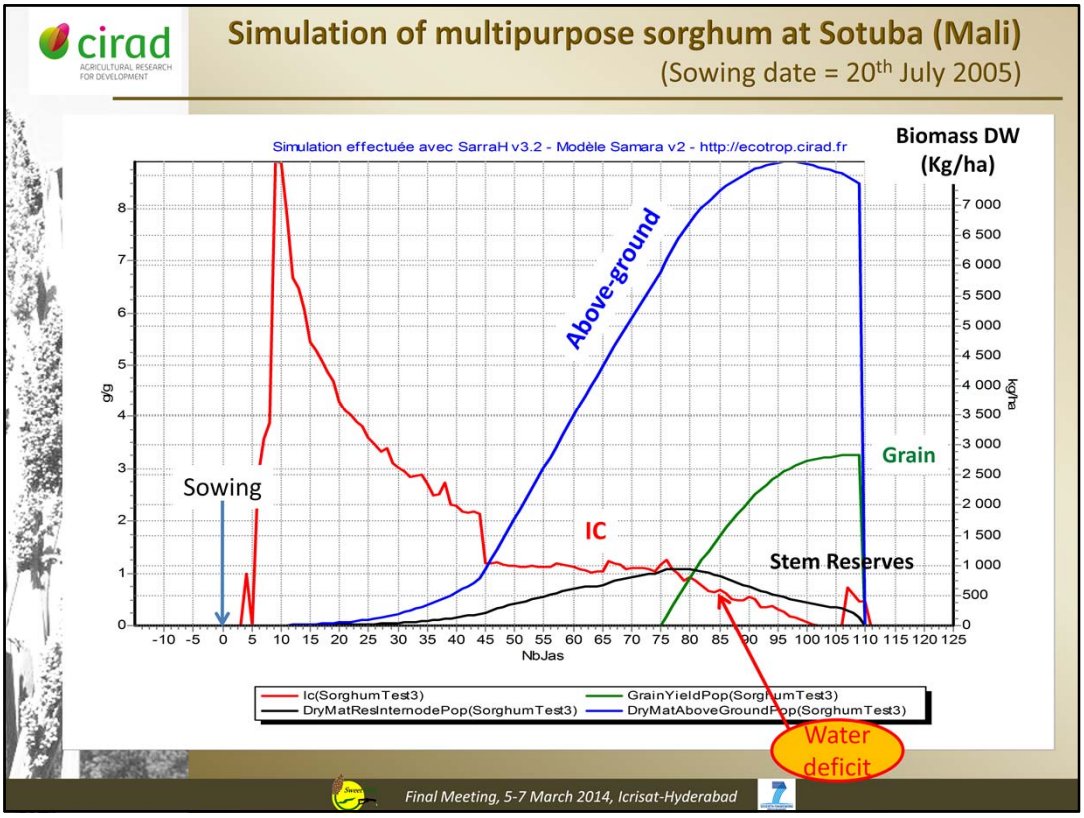
In such a situation, Samara simulates for this variety, grain yield at 4.5 t/ha, Total above groud biomass at 13 T/ha, and Stem reserves at 2.5 Kg/ha.



But for a later sowing date (1 month later), we can see that Ic is fallen less than 1 Eighty-ninety days after planting. At that time the rainy sasoon is off and a slight water deficit occurs.

We can see that such a stress has an effect on the stem reserves which diminish to about 0.5 T/ha. But it doesnt affect (or slightly affect) grain yield

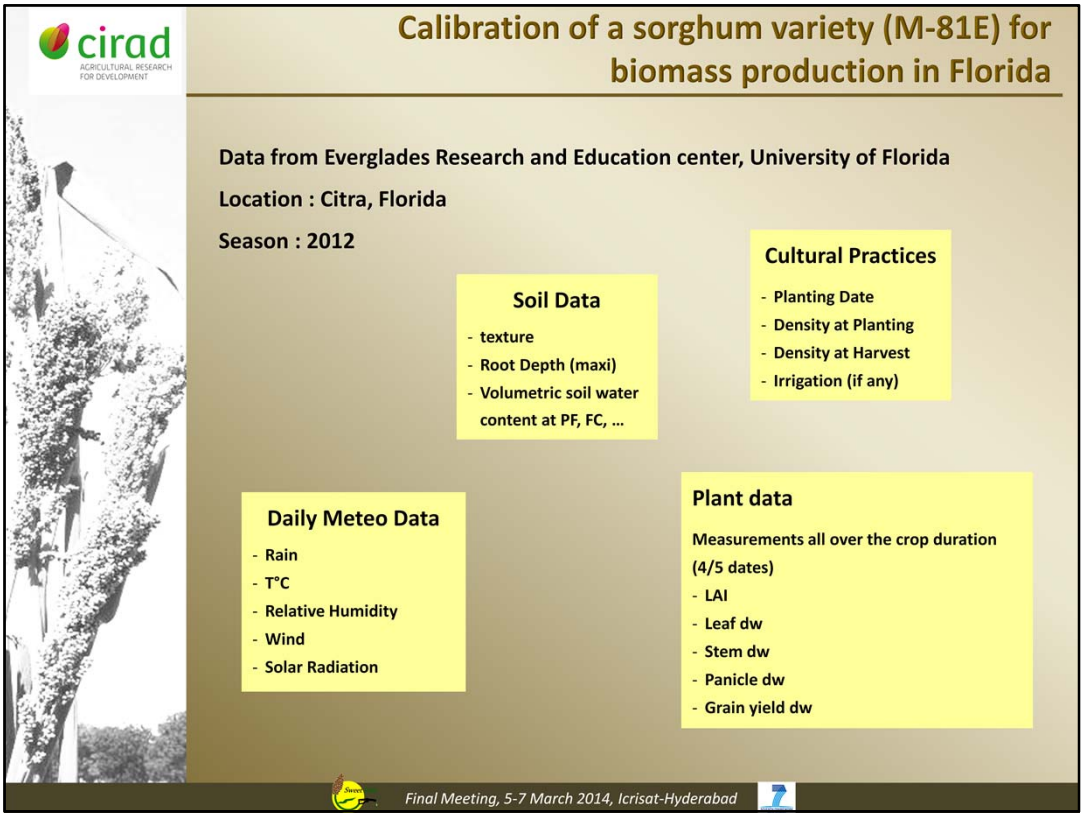
It means that Samara simulates a mobilization of the reserves to maintain Grain Yield



And if we plant later (for exemple on 20th of july, Ic is less than one earleir (_à days after planting) and the effects of water stress is morfe drastic.

Stem reserves are entirely consumed

And Grain Yield reduction is down to 2.5 t/ha



As a second example, this is the results of a calibration study we made using data from the Everglades Reserach and Education Center in Florida.

The objectives were to calibrate the sorghum variety M81E

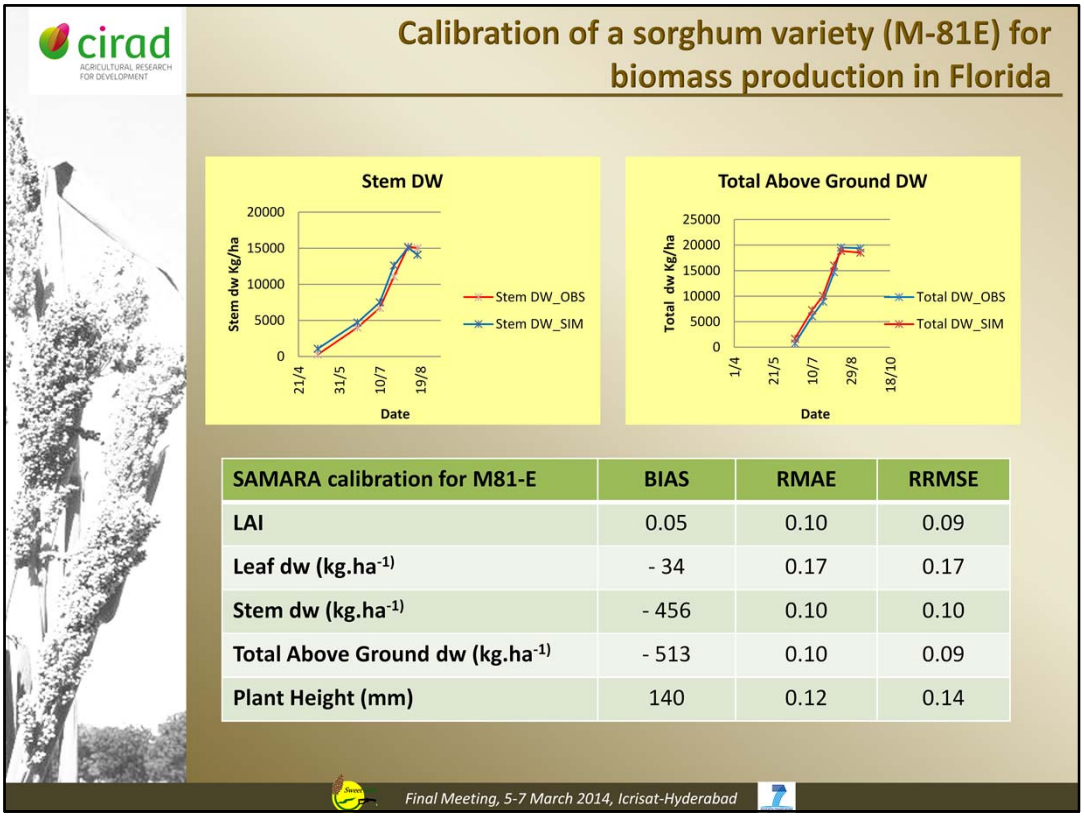
we used the data from a trial conducted at Citra Experimental Station in 2012

Rain mm
T° C Maxi , Mini
Atmospheric Relative Humidity Maxi, Mini
Wind (m/s)
Solar Radiation (MJ/m²)

Sandy soil,
Deep soil

Planting date : 10th of May
Planting density : 101.000 plant/ha
Density at Harvest : 102.000 plant/ha
About 1 panicle / plant

Date for measurements : 40, 60, 75, 90, 100 days after sowing + Harvest



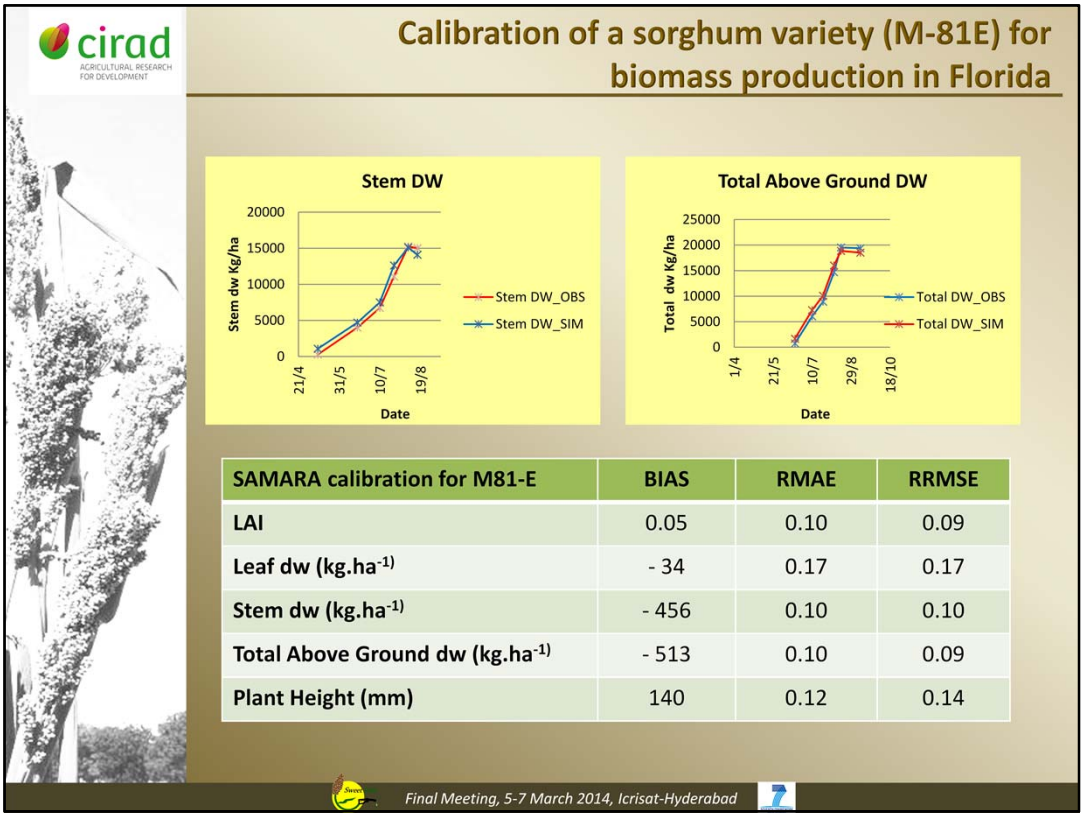
SAMARA calibration for M81-E	BIAS	RMAE	RRMSE
LAI	0.05	0.10	0.09
Leaf dw (kg.ha$^{-1)}$	- 34	0.17	0.17
Stem dw (kg.ha$^{-1)}$	- 456	0.10	0.10
Total Above Ground dw (kg.ha$^{-1)}$	- 513	0.10	0.09
Plant Height (mm)	140	0.12	0.14

RMAE : Relative Mean Absolute Error is more adapted for a series of successive measurements differing in size

= Mean [(IObs-SimI) / Obs]

RRMSE : Relative Root Mean Square Error

= Racine [Mean (Obs-Sim)^2] / Mean Obs



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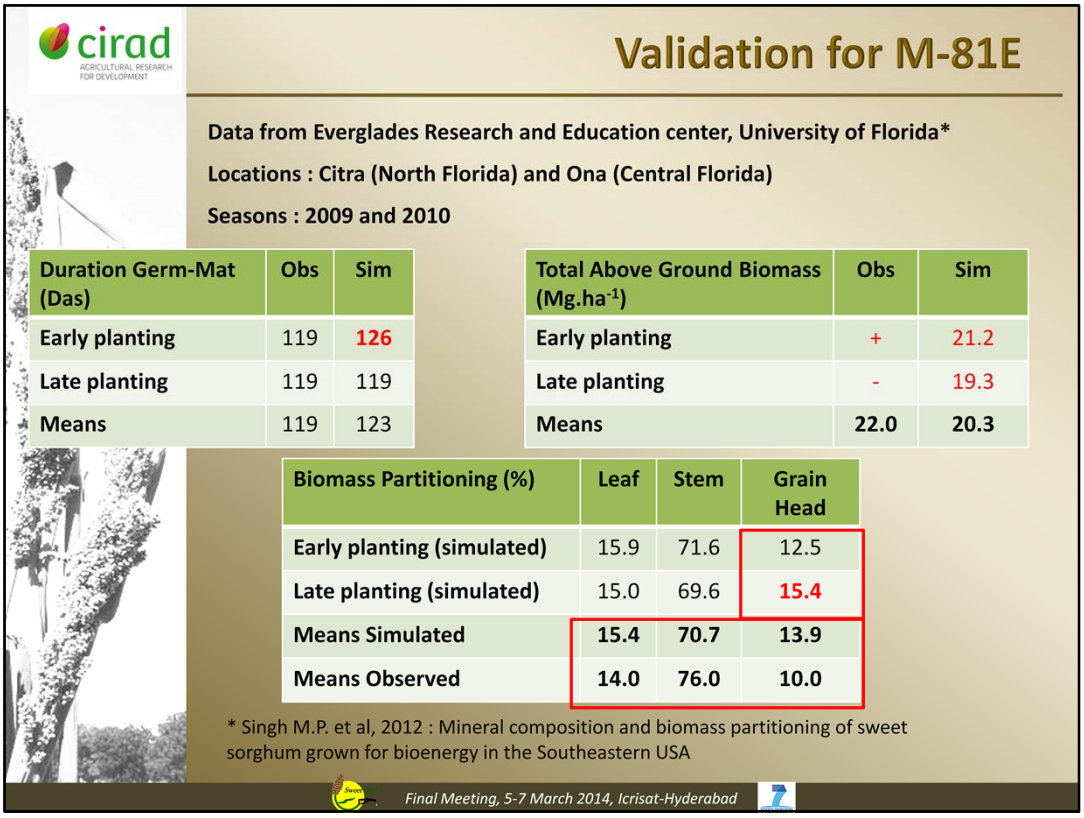


Then we had to validate that calibration using data from others experiments

Therefore, we used data collected in 2009 and 2010 at the Citra station (North of Florida) and at Ona Station in central Florida.

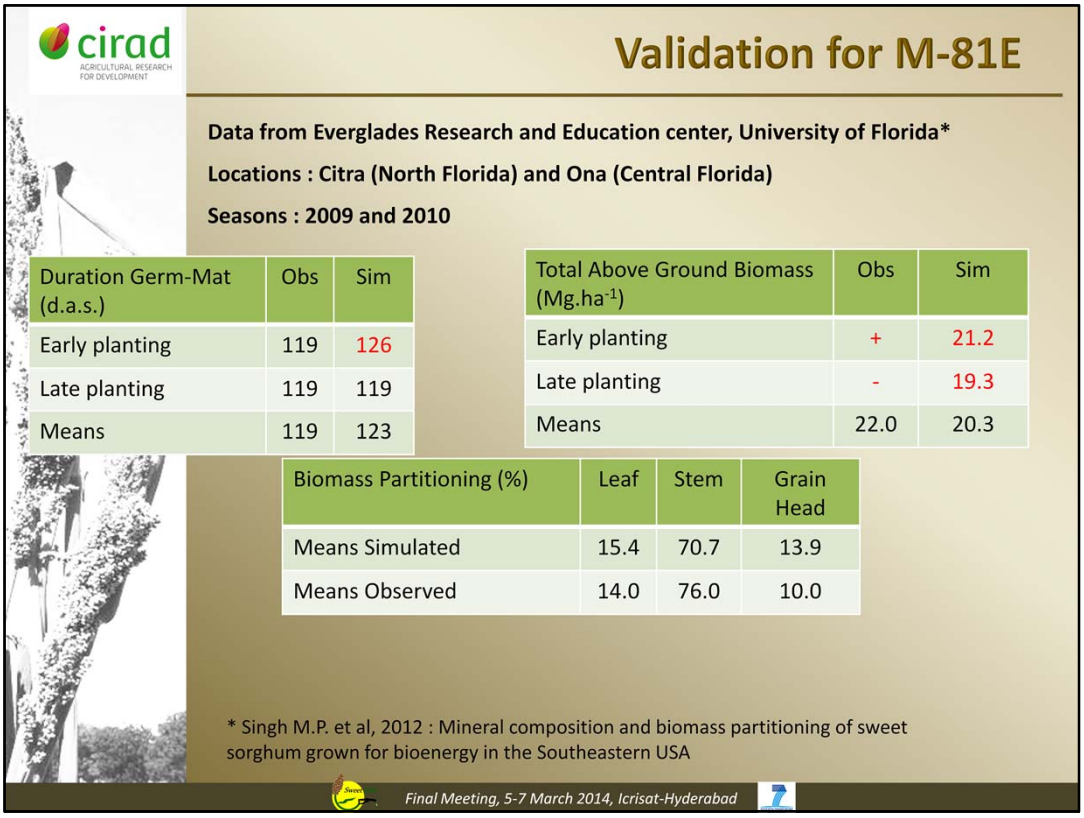
This table compares the duration between germination and maturation for field observation and simulation. There is no diference for late planting (119 days after sowing), whereas SAMARA simulates a longer duration for early planting (+7 days)

This is probably caused by lower temperatures during the early planting crop which is taken into account by Samara, but has no effect on the field

Regarding Total Above Ground Biomass, we havent got the detailed traetment data. But if look at means, SAMARA simulation is a little bit less than observed ,

but the Yield tendencies are reproduced as we can see that Early planting is more productive than late planting.

In the same idea (furthermore), Biomass partitioning (which was the objectives of the study) is quite well simulated, with the tendency for late planting to produce proportionaly more grain than early planting.



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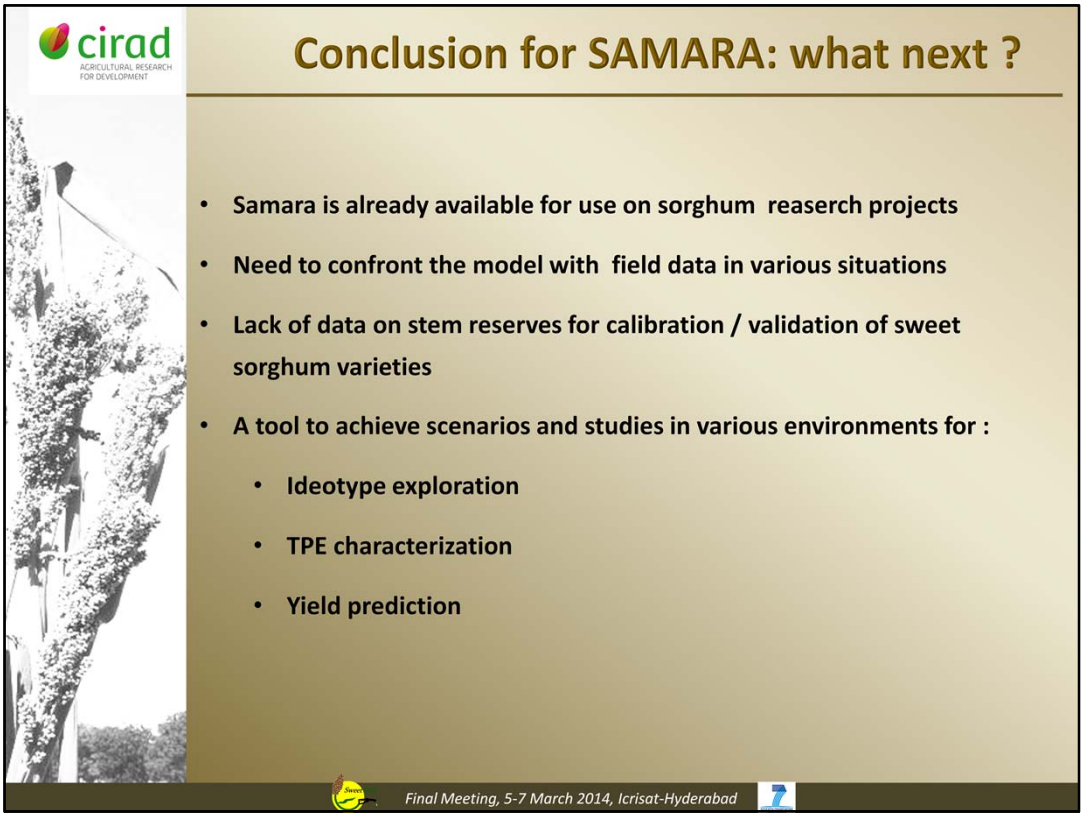

For validation in many situations and furthermore to know the limits of validity of the model


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Sweet Fuel

Sweet Sorghum an alternative energy Crop

SEVENTH FRAMEWORK PROGRAMME

N° 227422

CONSORTIUM

CIRAD (Coordinator + WP4 & WP8 leader)

KWS (WP1 Leader)

ICRISAT (WP2 Leader)

EMBRAPA (WP3 Leader)

UniBO (WP5 Leader)

IFEU (WP6 Leader)

WIP (WP7 Leader)

ARC-GCI

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Prof. M. BURSZTYN
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